Recommendations for a Department of Energy Nuclear Energy R&D Agenda

Appendix 1
Objectives of the Federal Government Nuclear Energy Related Policies and Research and Development Programs

1.0 INTRODUCTION

The current U. S. nuclear energy policy is primarily formulated as part of the nation's overall energy policy. In addition, nuclear energy policy is impacted by other U.S. policies, such as those for defense and environment, and by international obligations through their effects on nuclear weapons dismantlement and stewardship, continued reliance on space and naval nuclear power sources, defense waste cleanup, and on nuclear non-proliferation.

2.0 NATIONAL ENERGY POLICY

As succinctly stated in the 1995 National Energy Policy Plan[1] (NEPP), the current administration's energy policy focuses on development of sustainable energy supply, generation, and use and has three strategic goals:

- Maximize energy productivity.
- Reduce adverse environmental impacts.
- Reduce vulnerability to the global energy market.

[1] *Sustainable Energy Strategy—Clean and Secure Energy for a Competitive Economy*, July 1995, National Energy Policy Plan Pursuant to Section 801 of the Department of Energy Organization Act.

The NEPP identifies five strategic components contributing to the implementation of a sustainable energy policy. These are:

- Increase the energy efficiency.
- Develop a balanced domestic energy resource portfolio.
- Invest in science and technology.
- Reinvent environmental protection.
- Engage the international market.

Nuclear energy is specifically mentioned in the NEPP as one of the elements of a balanced domestic energy portfolio. According to the plan, the Administration's nuclear energy policy is:

> *"…to maintain the safe operation of existing nuclear plants in the United States and abroad, and to preserve the option to construct the next generation of nuclear energy plants."*

The safety component of the administration's policy is implemented along two major paths:

- Working with industry to enhance safety (both domestically and internationally).
- Continuing to press for safe storage of spent nuclear fuel.

The component focused on preserving the nuclear option is reflected in the Department's commitment to:

- Assist industry in the development of advanced light-water reactor designs.

In addition to the overt statements concerning nuclear energy policy, the NEPP defines policies and objectives that can be directly impacted by nuclear energy. Indeed, nuclear power can effectively contribute to each of the five strategic components of the NEPP.

Nuclear energy can improve the efficiency of primary energy use and reduce overall resource utilization. Use of advanced fuel cycles offers potential very long-term resource lifetimes.

Nuclear power R&D contributes directly and indirectly to a broad range of important science and technology advances. Materials science and control systems are just two examples of significant progress that has been achieved as a result of nuclear power development.

One of the more pressing international issues is that of greenhouse gas emissions and their effect on global climate change. This sensitivity is explicitly recognized in the NEPP:

Clear evidence of significant global climate changes or other energy-related environmental problems could precipitate widespread public demand for more stringent measures to reduce greenhouse gas emissions or other environmental risks from energy production and use. Many scientists believe that stronger evidence could emerge in the next decade or two indicating that human-induced climate changes would result in large adverse impacts. Although it is difficult to forecast how the international community would respond, nations that are less dependent on carbon-intensive fuels or that have developed and begun to deploy the technologies needed to reduce such dependence are likely to have an advantage.

Although not specifically mentioned, nuclear energy is the only currently deployable technology capable of significantly reducing dependence on carbon-containing fuels. Of the competitors, wind, solar and geothermal are unlikely to become major contributors to the nation's electrical grid in the next 10–20 years, and the nation's capacity for increased hydroelectric resources is near its limit and subject to considerable environmental concern.

With projections of significant growth in worldwide energy demand, particularly in the developing countries and in eastern Asia, interest in and potential markets for nuclear technologies are increasing rapidly. Although the U.S. nuclear industry was once the world's sole supplier of nuclear goods and services, that position of leadership has eroded in recent years. Active reengagement in the nuclear marketplace is needed if the U.S. is to avoid missing this lucrative market.

2.1 DOE Implementation

The Department of Energy has outlined its implementation of the administration's energy policy in its current "DOE Strategic Plan"[2] and identified five strategic goals, including one for each of four "businesses areas" and one for corporate management. These are paraphrased here:

- Energy resources—Assure adequate supplies of clean energy.
- National security—Provide a safe and reliable stockpile and weapons infrastructure, provide technical leadership in nonproliferation and nuclear safety, and support naval nuclear reactor technology.
- Environmental quality—Minimize environmental, health, and safety risks and impacts.

[2]DOE Strategic Plan, DOE/PO-0053, September 1997.

- Science and technology—Maintain leadership in science and technology.
- Corporate management—Protect the environment, ensure health and safety (both of workers and the public), build communication and trust (including stakeholders and customers), and demonstrate good management practices (including workforce and infrastructure management, cost, and schedule.)

In addition to the above goals, there is one additional overarching consideration that may be considered a strategic goal:

- Industrial competitiveness—Contribute to the nation's economic and industrial competitiveness in an increasingly global economy.

This latter goal was explicitly included in the 1994 DOE Strategic Plan,[3] and although the principle of industrial competitiveness is embedded in much of the current plan, it is not explicitly developed there.

3.0 HISTORICAL PERSPECTIVE

The Atomic Energy Act of 1946, as amended in 1954 and later, provided the nation's fundamental nuclear policies. It delineated the roles and separation of the peaceful and military uses of atomic energy. The Act declared in Section 1 that it is the policy of the United States that "the development, use, and control of atomic energy shall be directed so as to promote world peace, improve the general welfare, increase the standard of living, and strengthen free competition in private enterprise." The purpose of the Act, set forth in Section 3, is to effectuate the policy by providing for, in addition to defense related programs, (a) a program of conducting, assisting, and fostering research and development in order to encourage maximum scientific and industrial progress; (b) a program to encourage widespread participation in the development and utilization of atomic energy for peaceful purposes to the maximum extent consistent with the common defense and security and with the health and safety of the public; and (c) a program of international cooperation to promote common defense and security and to make available to cooperating nations the benefits of peaceful applications of atomic energy. The Act created the Atomic Energy Commission to carry out these programs and empowered it with the authority to conduct nuclear R&D and training programs, contract and make grants, and license and regulate reactors and nuclear materials.

[3] "Fueling a Competitive Economy," DOE Strategic Plan, DOE/S-0108, April 1994.

President Eisenhower, in his December 1953 “Atoms for Peace” speech, called for greater international cooperation in the development of atomic energy for peaceful purposes. In October 1957 the United Nations created the International Atomic Energy Agency (IAEA) to promote the peaceful use of nuclear energy worldwide and prevent the spread of nuclear weapons.

The official source of direction from Congress to the Department of Energy (DOE) with respect to nuclear energy R&D policy can be found in the Energy Policy Act of 1992 (EPACT). The EPACT was enacted in October 1992 and implemented and built upon strategies put forth by the Bush Administration in its National Energy Strategy (NES) published in February 1991. The NES clearly states that nuclear energy will continue to be important as a key component of a flexible, secure energy mix for the country. It predicted an increase in nuclear energy generation in the U.S. of 10% by 2010 if the measures it recommended are fully implemented. The NES describes four nuclear energy goals and approaches to achieve those goals:

Goal	Approach
Maintain exacting safety and design standards	Accelerate introduction of advanced design nuclear power plants
Reduce economic risk	Accelerate introduction of standard power plant designs
Reduce regulatory risk	Reform the NRC licensing process
Establish an effective high-level nuclear waste program	Site and license a permanent waste repository and a monitored retrievable storage facility

EPACT Title XXI, Energy and Environment, Subtitle C, Advanced Nuclear Reactor, Section 2121, requires DOE to carry out civilian nuclear programs in a way that will lead toward commercial availability of advanced nuclear reactor technologies. The DOE Office of Nuclear Energy, Science and Technology’s (NE) advanced reactor development projects underway at the time EPACT became law included the high temperature gas-cooled reactor (HTGR), the advanced liquid metal reactor (ALMR), the actinide burn technology evaluation (Integral Fast Reactor), and the advanced light water reactor (ALWR). Section 2124 of EPACT directed DOE to complete R&D on HTGR and ALMR designs to support selection of one or both designs for prototype construction by September 30, 1998. Congress canceled the ALMR and IFR projects in FY1995 and the HTGR in FY1996.

EPACT Section 2121 directed DOE to further timely availability of advanced nuclear reactor technologies, including technologies that use standardized

designs or exhibit passive safety features. In Section 2123, DOE was authorized to continue its cost-shared program with industry to complete design certification of the advanced light water reactors (ALWR) and to conduct the first-of-a-kind engineering (FOAKE) program. Two of three ALWR designs were certified by the Nuclear Regulatory Commission in May 1997 (General Electric advanced boiling water reactor and ABB-Combustion Engineering System 80+), and the third (Westinghouse AP600) is projected for final design approval in 1998 and certification in 1999. The FOAKE program developed designs more completely for two plants, the ABWR and the AP600. The program was limited to four years and had a $100 million funding cap. FOAKE was completed for the ABWR in FY 1996 and for the AP600 in FY 1997.

EPACT also contains provisions regarding cost-sharing of energy R&D programs. For demonstration or commercial application projects, at least 50% of the costs must be provided from non-Federal sources. The Secretary of Energy may reduce or eliminate the cost-share requirement if he/she determines that the reduction is necessary and appropriate considering the technological risks involved in the project.

When the Clinton Administration took office in early 1993, the new President's policy on nuclear energy was made clear in his inaugural address and published in his "Vision of a Change for America", issued via the Office of Management and Budget, in February 1993. His statement was clear in that his energy policy included the elimination of unnecessary nuclear reactor research. The administration supports funding in R&D to maintain operation of the current generation of reactors and licensing actions of reactors that have commercial interest. This argument was used to continue ALWR, FOAKE, and commercial LWR plant life improvement programs. However, it eliminated R&D funding support for reactors which have no near-term commercial or other identified application. This resulted in cancellation of the HTGR, ALMR and IFR programs in 1995–1996.

The Secretary of Energy published the first DOE Strategic Plan in April 1994. As stated above, this document made no definite policy statements regarding use of nuclear energy. It did, however, mention continued operation of safe, economical nuclear power plants as one of several methods available to reduce greenhouse gases. The 1997 DOE Strategic Plan states that "by resolving nuclear waste disposal issues and developing advanced nuclear technology, DOE will remove some concerns and may open the door to renewed consideration of nuclear energy as an additional option for addressing air quality and greenhouse gas emissions."

3.1 Emphasis on Nuclear Safety

The DOE Office of Nuclear Energy, Science and Technology (DOE-NE) developed a draft strategic plan of its own in 1994–1995 to support the DOE strategic plan. Among the goals of DOE-NE were to:

- Cooperate and coordinate with other departmental offices and government agencies in the implementation of U.S. non-proliferation policy. This goal's objectives were to assist in the cessation of weapons-grade plutonium production in Russia; monitor low-enriched uranium purchased from Russia to verify it was blended down from highly-enriched uranium (HEU); maintain U.S. leadership in technical and programmatic aspects of international reprocessing and related reactor programs, and promote alternative technologies; and maximize the use of existing programs to increase the transition of former Soviet Union nuclear and weapons scientists to non-defense activities.
- Foster increase in U.S. exports of nuclear goods and services. This goal had two objectives: to facilitate and increase commercial contracts between U.S. suppliers and potential foreign buyers; and to overcome obstacles to U.S. nuclear supplier participation in foreign markets.
- Support maintenance of the light water reactor (LWR) option for domestic electricity generation. The objectives of this goal were to complete the design certification of advanced evolutionary and passive LWRs ; encourage commercial standardization by completing the FOAKE program for evolutionary and passive ALWR designs, and perform remaining detailed design work to achieve the design stage of commercial standardization; establish and demonstrate the license renewal process, in cooperation with industry and the NRC; develop technology to manage the effects of material degradation on key nuclear plant equipment that impacts safety; support development of technology and methods to improve plant performance and economics, while maintaining safety; and support technology to improve decommissioning and decontamination (D&D) and plant life decisions.

The DOE-NE strategic plan remains a draft document, not yet formally approved by the Office Director.

In July 1995 the Department of Energy issued the Sustainable Energy Strategy document, described earlier, which presented the Clinton Administration's national energy policy as a National Energy Policy Plan. This document contains all of the current policies in effect for the use of nuclear energy in the U.S. The Administration's nuclear energy policies include:

- Maintain the safe operation of existing nuclear plants in the United States and abroad and preserve the option to construct the next generation of nuclear energy plants.

- Increase operational safety at existing nuclear power plants. A top priority is achieving the greatest possible degree of global nuclear safety.

- Promote improving the safety of nuclear energy abroad by actively supporting the U.S. nuclear industry's pursuit of the multi billion-dollar international nuclear energy export market.

- Expedite the characterization of a geological repository as a safe method for high-level waste disposal and, if determined to be safe, build a geological repository to accept commercial nuclear waste. The characterization of Yucca Mountain is scheduled to be completed by the end of 1998, and if acceptable, the repository will be completed by 2010.

The current DOE program status for nuclear energy technology development is as follows:

- The ALWR program completed in FY 1997; no further DOE funds are budgeted for it.

  The ABWR and System 80+ evolutionary ALWR designs were certified by NRC in May 1997.
- The AP600 is expected to receive NRC final design approval in mid-1998 and enter the NRC rulemaking process for final design certification, which could take another year. Westinghouse and industry will have to fund the remaining effort needed to achieve certification.
- The FOAKE program was completed for the ABWR in September 1996. The FOAKE program for the AP600 is about 80% complete and will be completed by Westinghouse in conjunction with design certification.
- The advanced reactor severe accident program (ARSAP) was completed for the AP600 design in 1997.

DOE proposed in its FY 1998 budget request a new Nuclear Energy Security Program, which was designed to promote license renewal of existing plants, develop advanced technologies for improved safety and performance of existing and new plants, and minimize the generation of spent nuclear fuel. The details of the Nuclear Energy Security Program are discussed under Objective 2. The FY 1998 Energy and Water Resources appropriations bill provides no funding for this program. Thus, for the first time since the U.S. started its civilian nuclear energy program, there is no current government role in the nuclear energy R&D program.

3.2 High-level Waste

The Nuclear Waste Policy Act (NWPA) of 1982 established a program to site a repository for the disposal of high-level radioactive waste, including spent fuel from commercial nuclear reactors. It also established the Nuclear Waste Fund with a fee structure for nuclear power plant owners and generators of radioactive waste and spent nuclear fuel (SNF) to pay for the program. The NWPA was amended in 1987 to direct DOE to study only one site, Yucca Mountain in Nevada, for the permanent repository. DOE was also directed to begin moving SNF to the permanent repository by January 31, 1998. An interim storage facility, the monitored retrievable storage (MRS) facility, other than the temporary storage facilities at the nuclear power plant sites, was authorized initially but no volunteer host sites were identified before Congress stopped funding the MRS effort in 1995.

The EPACT Title VIII (High-level Radioactive Waste) Section 801 directs the Administrator of the Environmental Protection Agency (EPA) to set public health and safety standards for the Yucca Mountain site, after commissioning the National Academy of Sciences to conduct a study and make recommendations. NRC is directed to modify its rulemaking to incorporate the EPA standards, and DOE is to implement the standards. DOE is also required to report whether its nuclear waste management plan and program is adequate for management of additional nuclear wastes that might be generated by new nuclear power plants.

The current status of the permanent repository is that the Yucca Mountain characterization studies are in progress and are expected to be completed by the end of 1998. If Yucca Mountain is found to be acceptable as a site, DOE plans on building the repository there and being ready to accept SNF shipments from commercial nuclear power plants by 2010.

In 1997, both houses of Congress passed legislation requiring DOE to provide a temporary central storage facility for spent nuclear fuel and defense high-level waste. A joint conference committee to finalize the bill to be sent to the President will meet early in 1998.

3.3 Nonproliferation

The Nuclear Non-proliferation Treaty (NPT) process was begun in 1964 by an Eighteen-Nation Disarmament Committee (ENDC). Several years of negotiations among the world's nuclear weapons states culminated in a treaty that was signed by President Johnson and 61 other national leaders in July 1968. The Senate approved the treaty, and the U.S. ratified the treaty on March 5, 1970. With respect to nuclear energy technology, the treaty provides for (a) assurance, through international safeguards, that the peaceful nuclear

activities of non-nuclear weapons states will not be diverted to making nuclear weapons; and (b) promoting the peaceful uses of atomic energy, to include the potential benefits of any peaceful application of nuclear explosion technology being made available to nonnuclear parties under international observation.

Article VIII of the treaty required a conference every five years to review the treaty. The 1975 conference expressed firm support for IAEA safeguards and recommended that greater efforts be made to make them universal and more effective. It also urged common export requirements designed to extend safeguards to all peaceful nuclear activities, called "comprehensive safeguards." It also concluded that treaty compliance should facilitate access to peaceful nuclear assistance and credit arrangements.

The 1985 conference endorsed the IAEA and its safeguards system and examined ways to strengthen peaceful nuclear cooperation. Although it was unable to agree that "comprehensive safeguards" should be a precondition for significant nuclear exports to non-NPT, non-nuclear weapons states, the conference agreed not only on the desirability of such safeguards in non-nuclear weapons states but also that effective steps should be taken to achieve them.

The 1990 NPT review conference endorsed full-scope IAEA safeguards as a condition of significant nuclear supply, tighter export controls on nuclear technology transfers, and further cooperation in the peaceful uses of nuclear energy.

To implement export controls requirements of the NPT, the Zangger Committee was organized in the early 1970s. Article III of the NPT requires each member state not to provide source or special fissionable material, nor equipment or material designed for the processing, use or production of special fissionable material, to any non-nuclear weapons state for peaceful purposes, unless the source or special fissionable material shall be subject to IAEA safeguards. The Zangger Committee developed a list of controlled items, called the Trigger List because export of those items triggers IAEA safeguards. The list contains items that if misused could contribute to a nuclear weapons program, including plutonium, highly-enriched uranium (HEU), reactors, reprocessing and enrichment plants, and equipment and components for such facilities. The Zangger Committee meets twice a year and updates the Trigger List.

Another NPT-inspired group, called the Nuclear Suppliers Group (NSG), was organized by the U.S. in 1974 after India exploded a nuclear device. The group is now up to 34 members and has a stated purpose to ensure that nuclear technology suppliers uniformly apply a comprehensive set of guidelines to ensure that nuclear cooperation does not contribute to proliferation. The

guidelines for Trigger List exports require an agreement between IAEA and the recipient state demanding full-scope safeguards on *all* of its nuclear materials, not just the exported items; physical protection against unauthorized use of transferred materials and facilities; and restraints in the transfer of sensitive facilities, technology, and weapons-usable materials, i.e., exports that could contribute to the acquisition of plutonium or HEU. The NSG issued guidelines in 1992 to control "dual-use" goods, i.e., those which could have a nuclear weapons application, to minimize the risk of diversion of those goods.

The Atomic Energy Act of 1954, as amended, requires the NRC to issue an export license prior to the export of a nuclear facility or its components. An approved "Agreement for Cooperation in the Peaceful Uses of Atomic Energy" between the U.S. and the country where the export is bound is required. The Secretary of Energy must also authorize the export of nuclear power plant technology, since nuclear power plants produce plutonium during operation, per 10CFR810. Congress has the ability to block nuclear technology exports if it does not agree with the Executive Branch's desires, as it has in the case of China in the Foreign Relations Authorization Act of 1990.

The Nuclear Non-Proliferation Act of 1978 contained President Carter's policy statement against U.S. participation in the reprocessing of spent nuclear fuel. This policy statement continues to provide the basis of U.S. policy.

The current Administration's policy on nonproliferation and export controls was announced by the President at his United Nations address delivered on September 27, 1993. This policy is enforced through Presidential Decision Directive (PD) 13, also issued on September 27, 1993, which specifically states that it is U.S. policy not to encourage the civil use of plutonium. These documents contain the following key policy elements:

- The U.S. will eliminate where possible stockpiles of HEU and plutonium, and ensure that, where they continue to exist, they are afforded the highest standards of safety, security, and international accountability.
- The U.S. will propose a multinational convention prohibiting the production of HEU or plutonium for nuclear weapons purposes or outside of international safeguards.
- Submit U.S. fissile material no longer needed for our weapons program to IAEA inspection.
- Pursue the purchase of HEU from former Soviet Union countries for its conversion to commercial fuel.
- Explore means to limit the stockpiling of plutonium from civil nuclear programs.
- Seek to minimize the civil use of HEU.

- Initiate a comprehensive review of long-term options for plutonium disposition, taking into account technical, nonproliferation, environmental, budgetary, and economic considerations.
- The U.S. does not encourage the civil use of plutonium, and accordingly does not itself engage in plutonium reprocessing for either nuclear power or nuclear explosive purposes.
- Dual-use technology export controls will be reviewed and eliminated unless required for national security and foreign policy interests.
- Nonproliferation export controls implementation procedures will be streamlined.